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Herr

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(54) **HAND-HELD TOOL DEVICE**

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(51) **Int. Cl.**

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B25D 16/00	(2006.01)
B25D 11/08	(2006.01)
B25D 11/02	(2006.01)

(52) **U.S. Cl.**

CPC ***F16H 1/46*** (2013.01); ***B25D 11/02*** (2013.01); ***B25D 11/08*** (2013.01); ***B25D 16/003*** (2013.01); ***B25D 16/006*** (2013.01); *B25D 2216/0015* (2013.01); *B25D 2216/0023* (2013.01); *B25D 2216/0038* (2013.01); *B25D 2216/0084* (2013.01); *B25D 2250/165* (2013.01); *B25D 2250/255* (2013.01)

(58) **Field of Classification Search**

USPC 475/269, 275, 296, 317, 330

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,142,242	A *	11/2000	Okumura et al.	173/48
2004/0245005	A1 *	12/2004	Toyama et al.	173/48
2008/0167158	A1 *	7/2008	Chen	475/298
2008/0308286	A1 *	12/2008	Puzio	173/210
2012/0322605	A1 *	12/2012	Hirabayashi	475/149
2013/0161042	A1 *	6/2013	Blum et al.	173/48
2013/0165291	A1 *	6/2013	Blum et al.	475/269

FOREIGN PATENT DOCUMENTS

DE	10 2009 027 440	1/2011
EP	1 857 228	11/2007

* cited by examiner

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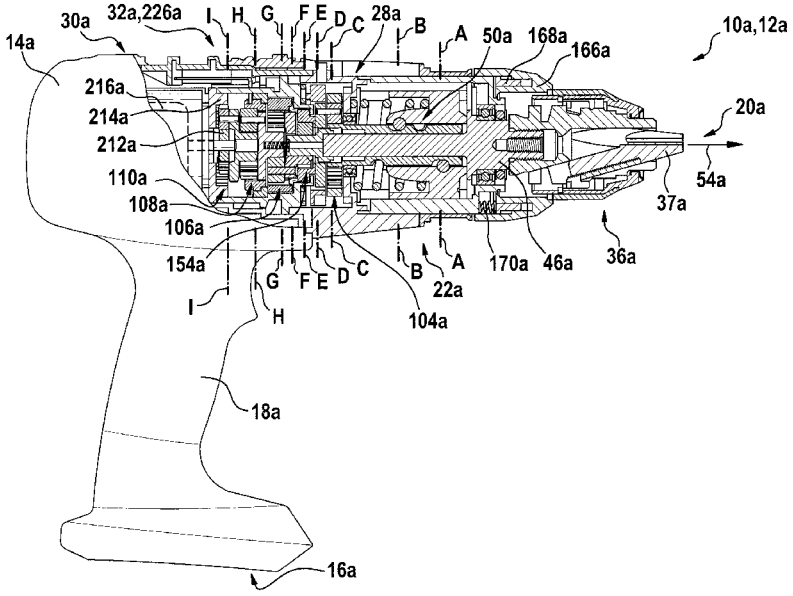
(57) **ABSTRACT**

A hand-held tool device includes: a tool spindle; a striking mechanism; and a planetary transmission having at least one first planetary transmission stage which drives the striking mechanism, a second planetary transmission stage which drives the tool spindle, and a striking mechanism shut-off clutch.

9 Claims, 11 Drawing Sheets



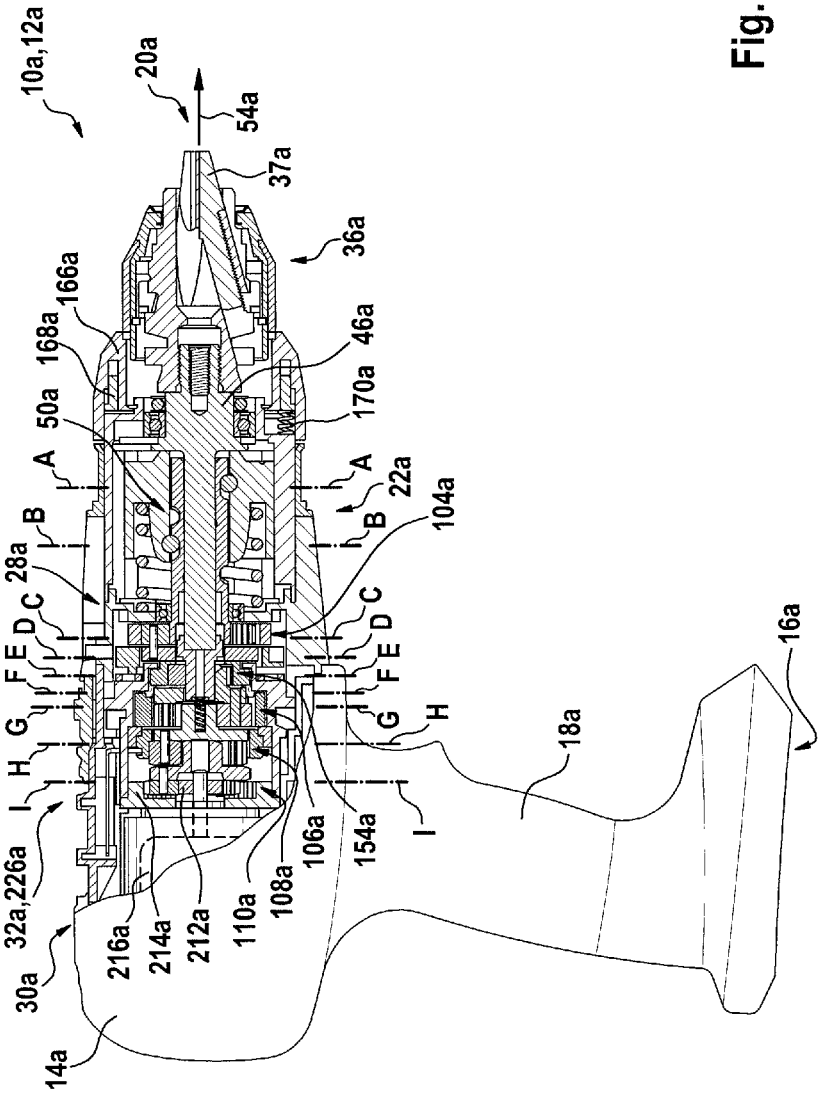

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Fig. 1

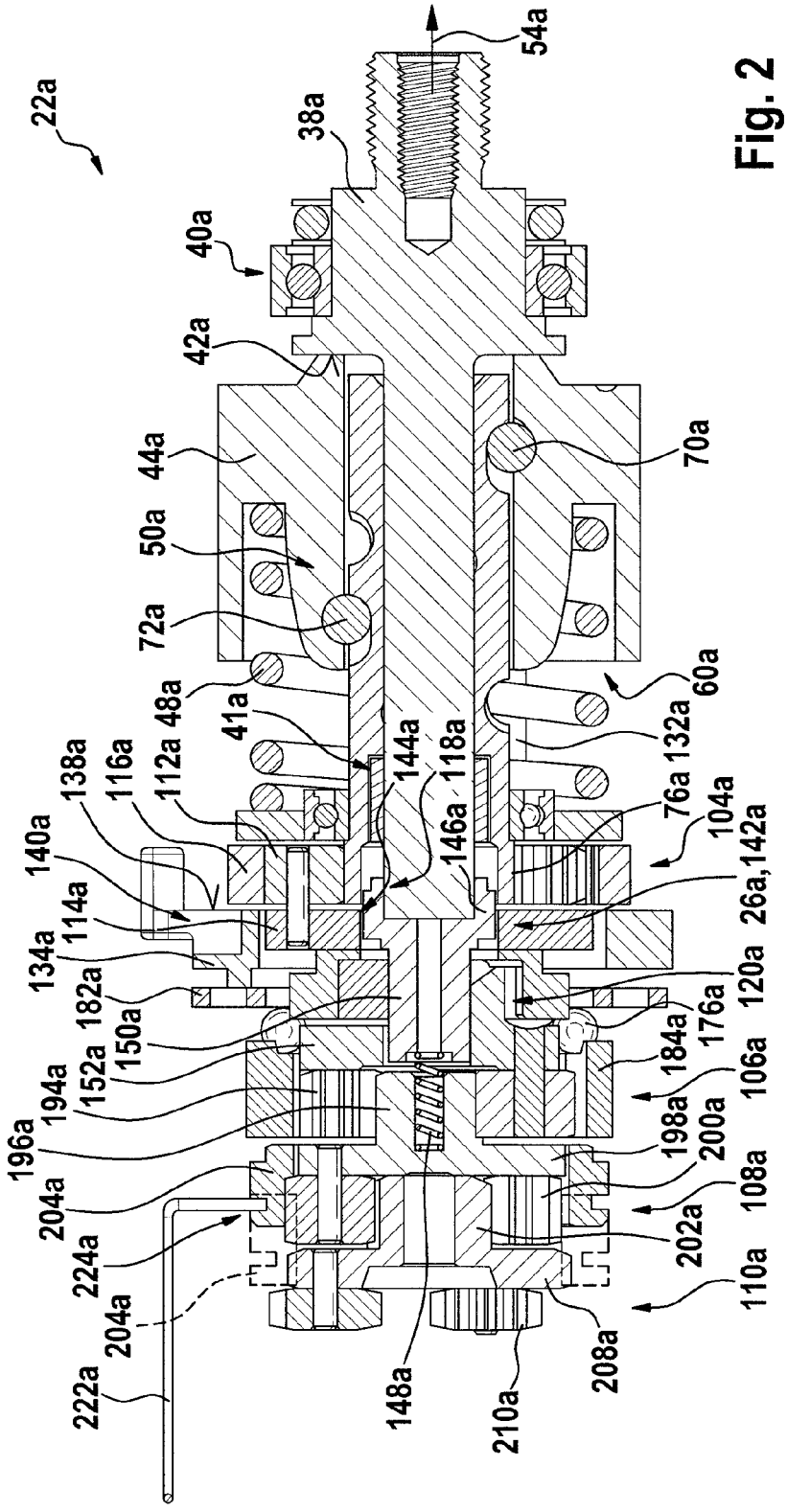
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Fig. 2

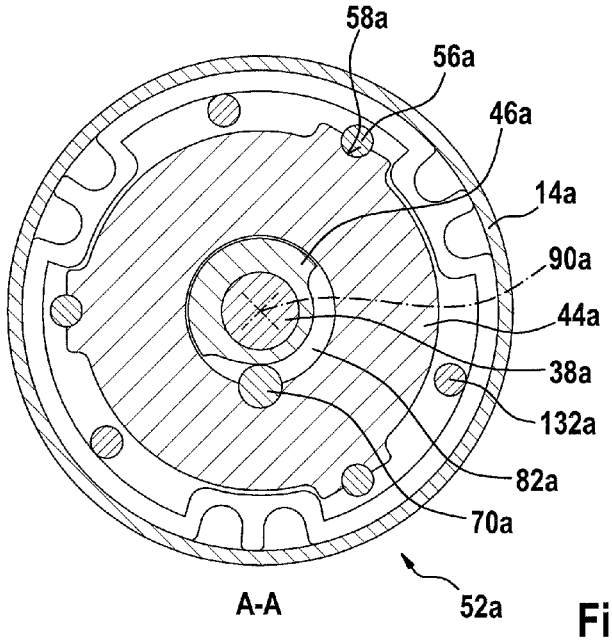
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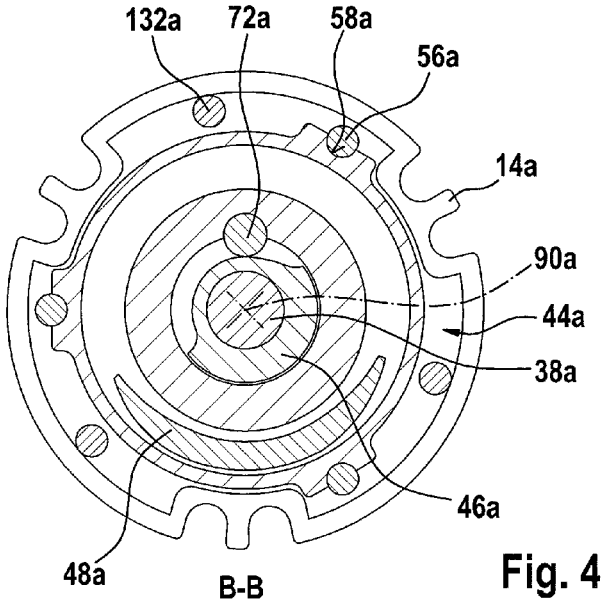
Fig. 3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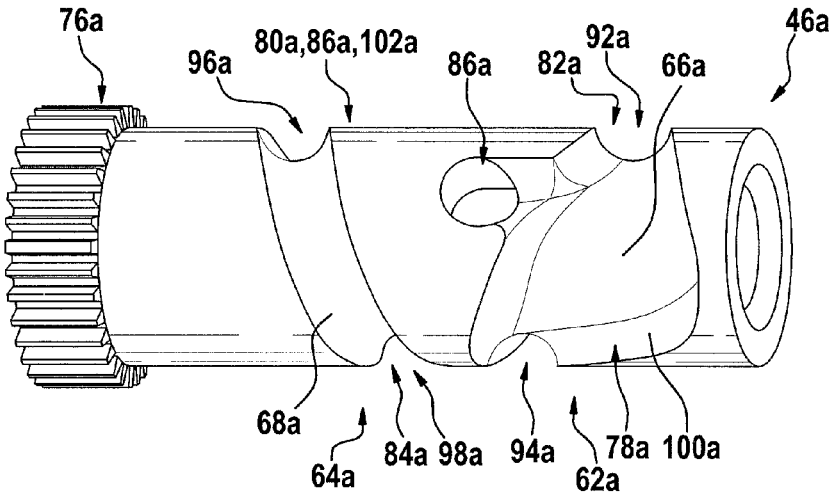
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Fig. 5

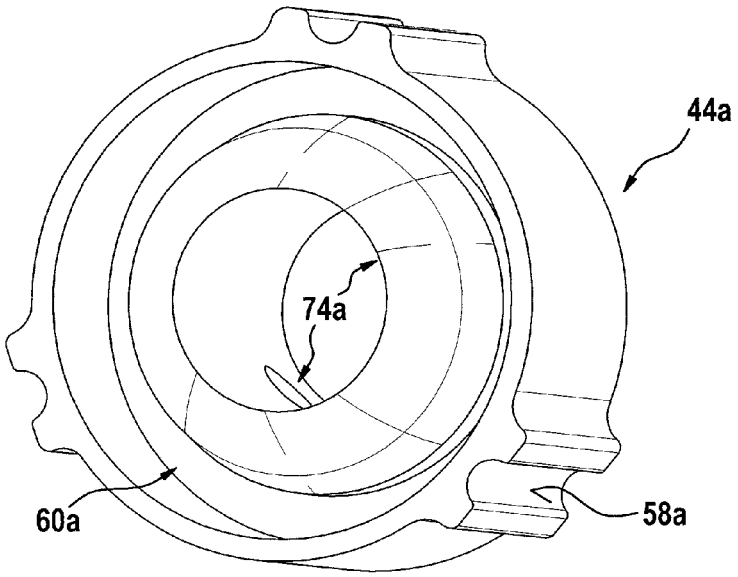
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Fig. 6

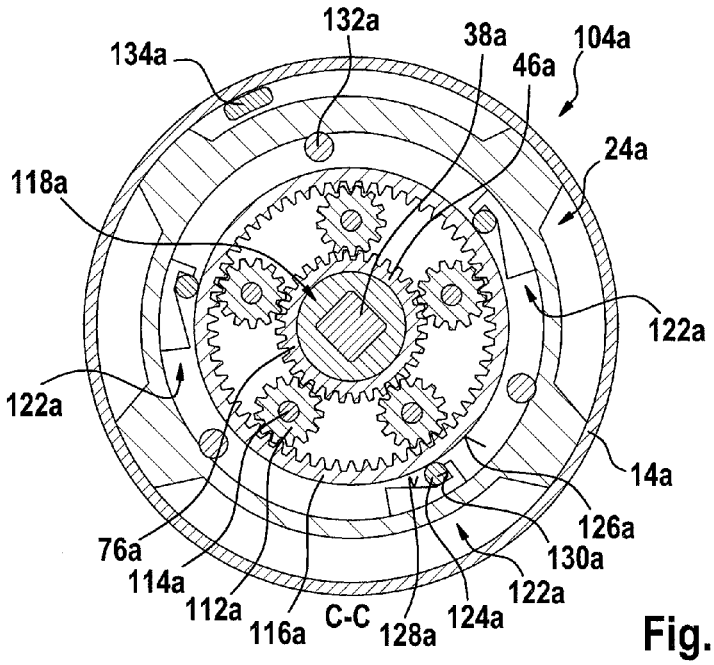
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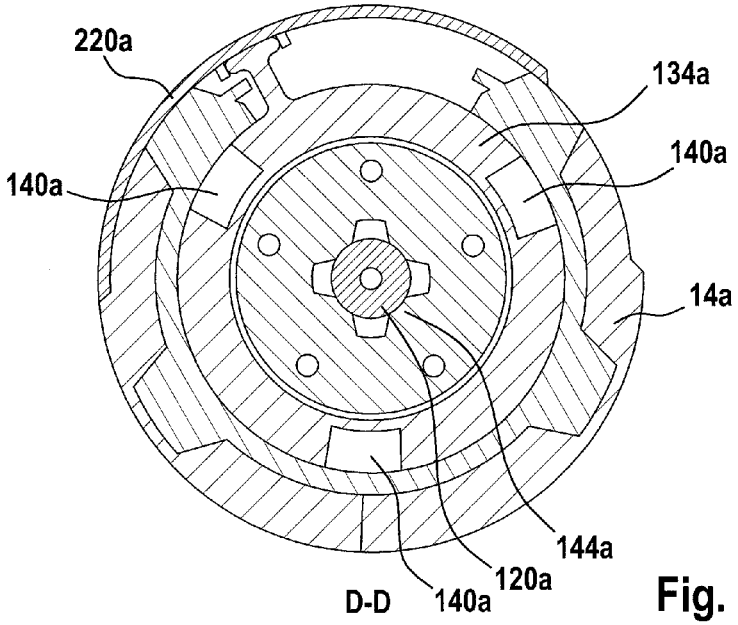
Fig. 7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D-D
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Fig. 8

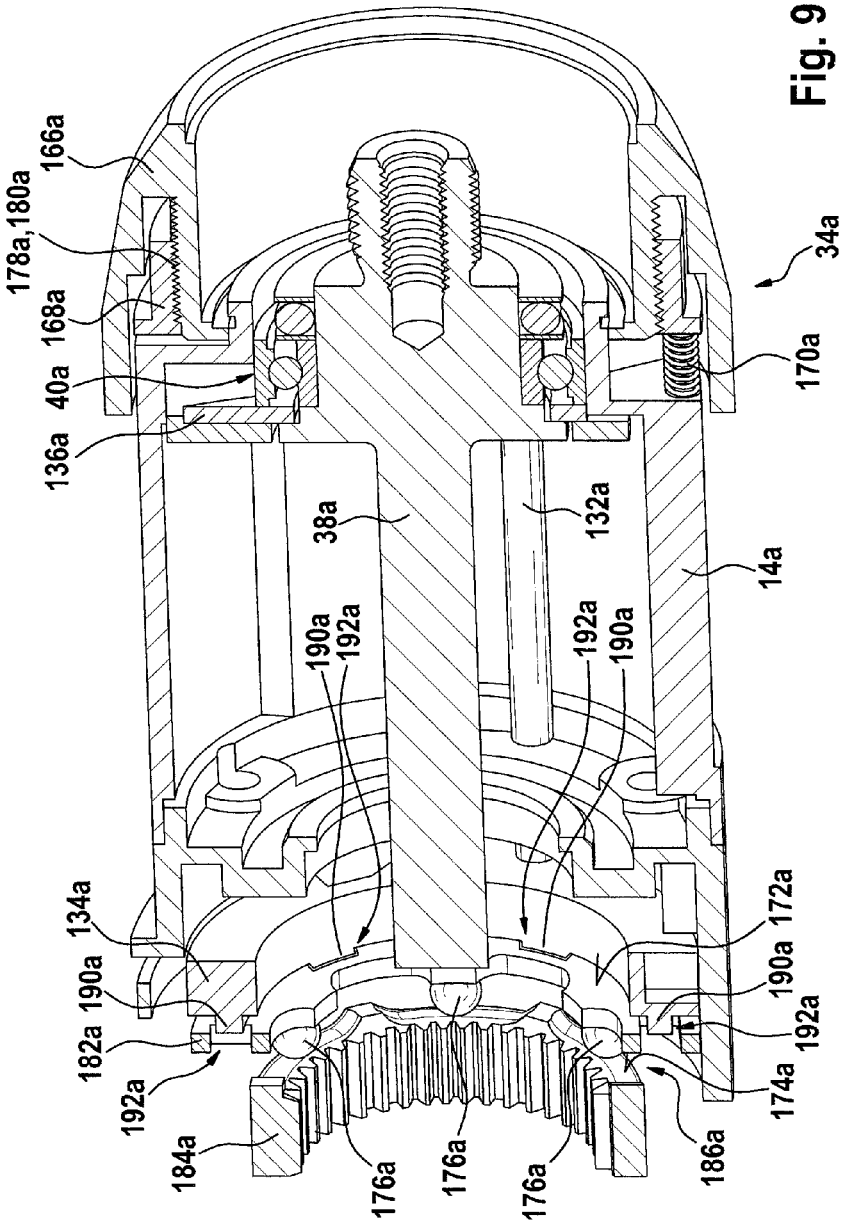
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Fig. 9

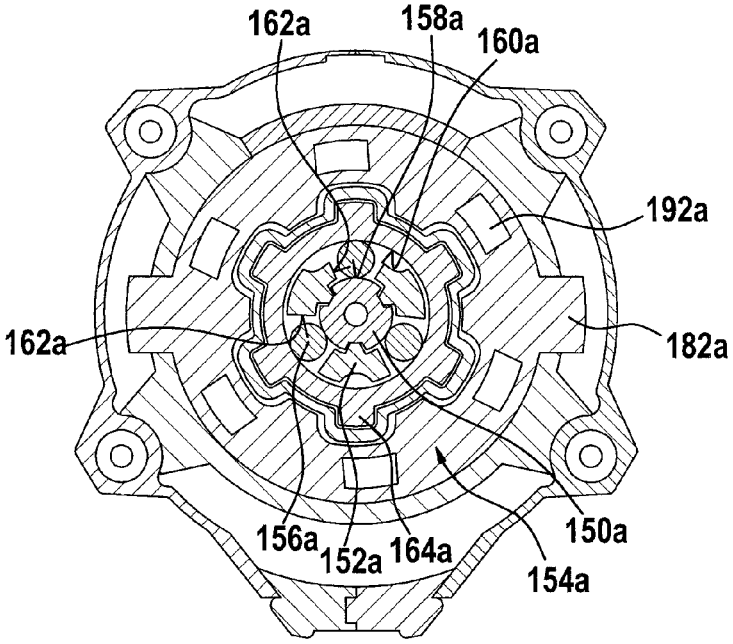

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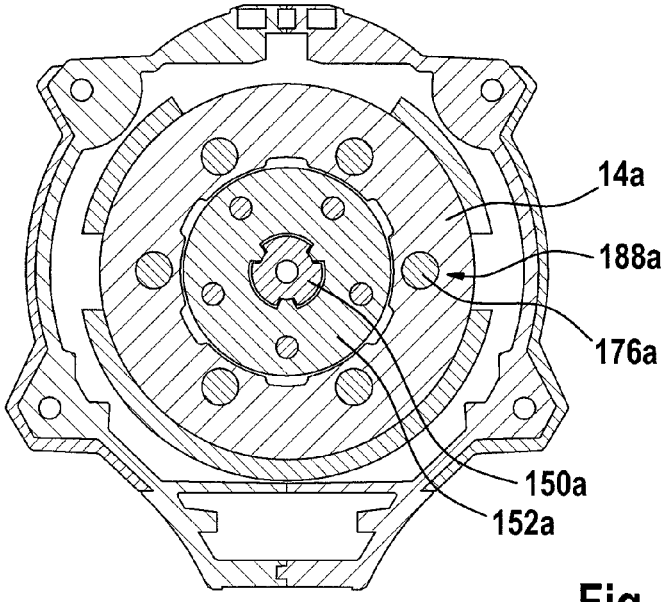
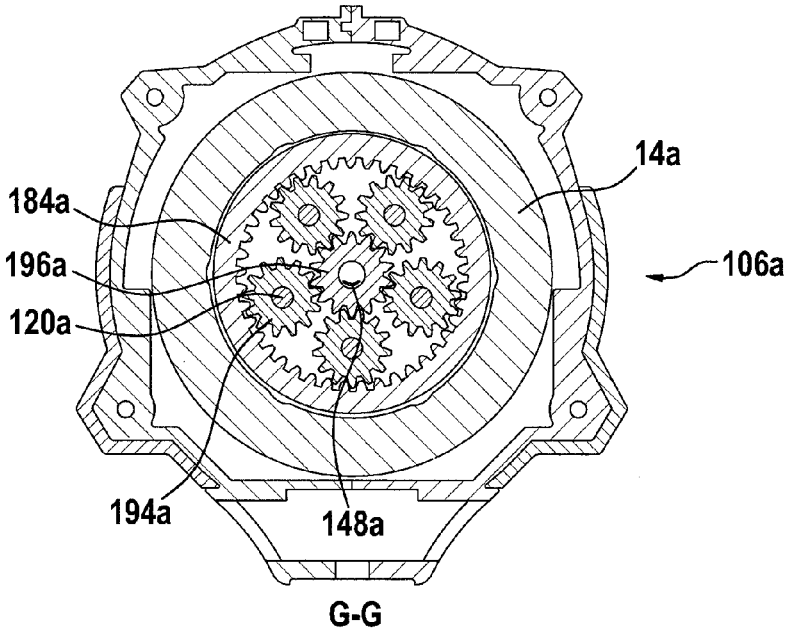
Fig. 10



F-F

Fig. 11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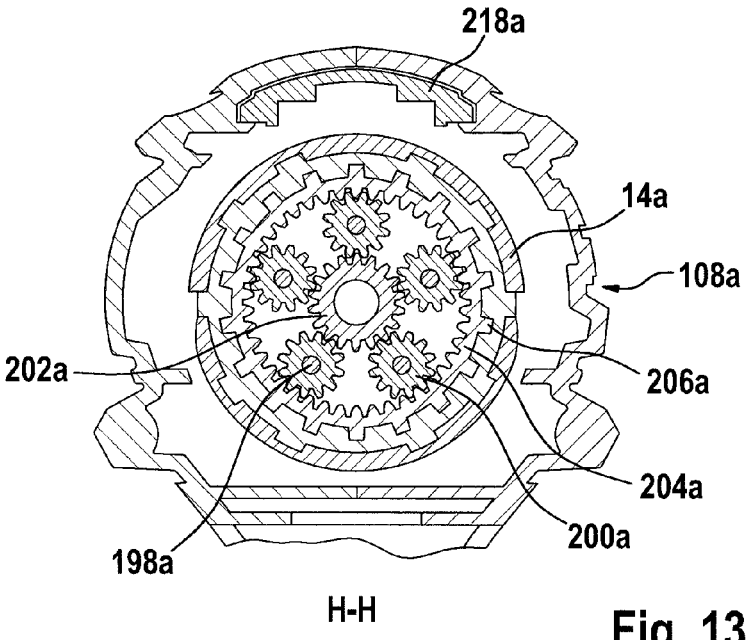
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Fig. 13

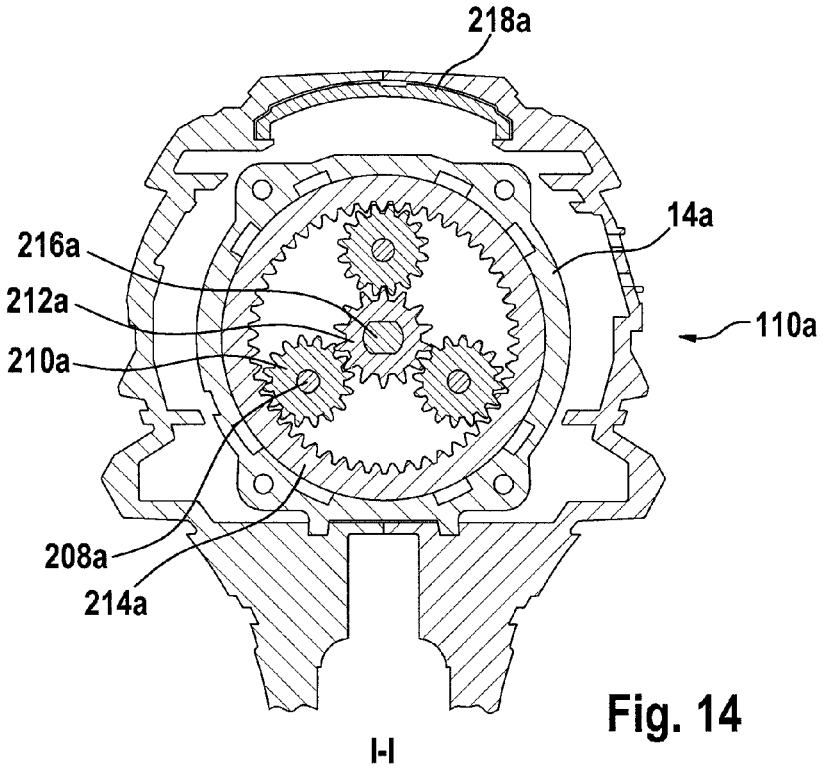
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Fig. 14

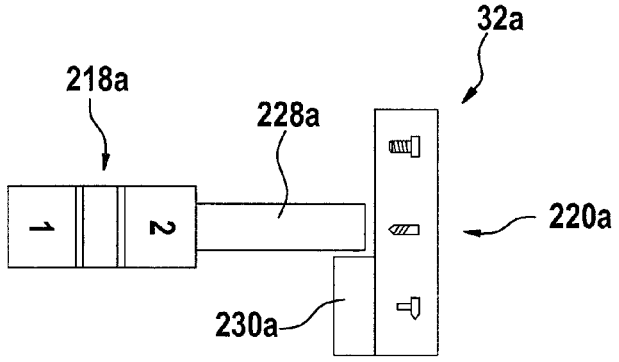
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Fig. 15

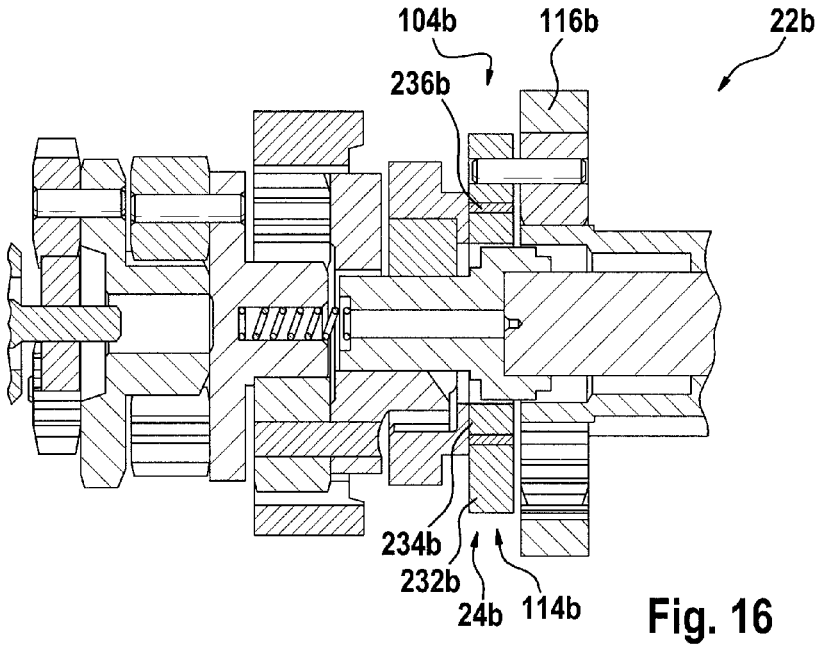
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Fig. 16

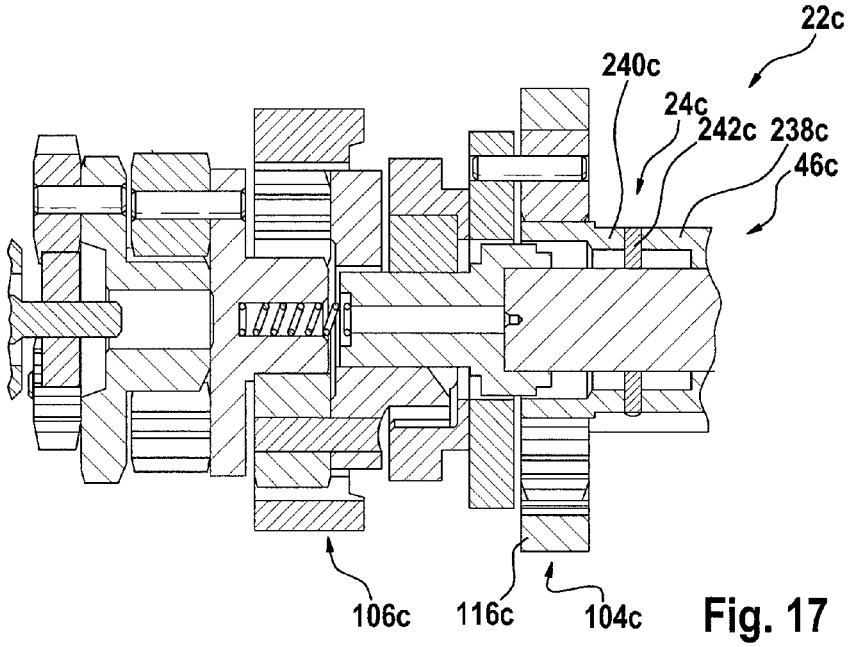
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Fig. 17

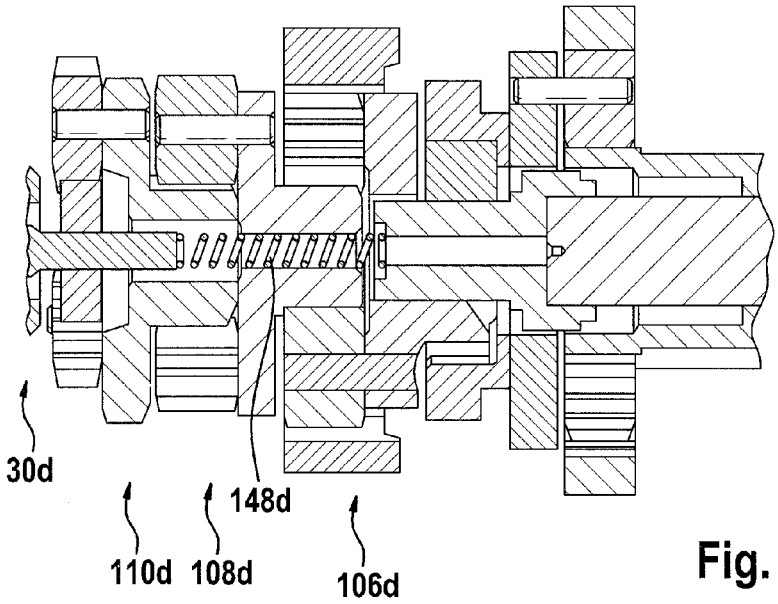
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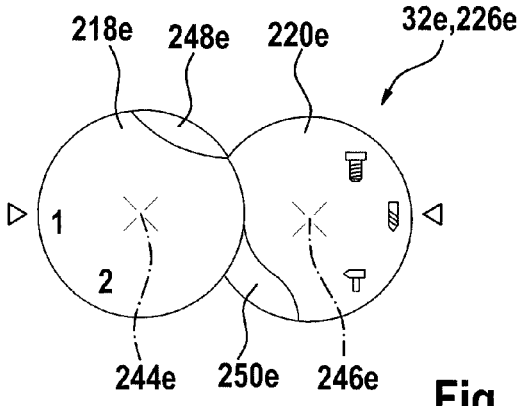
Fig. 18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2
244e
250e
246e

Fig. 19

HAND-HELD TOOL DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a hand-held tool device which has a tool spindle, a striking mechanism and a planetary transmission, that has at least one first planetary transmission stage which drives the striking mechanism, and a second planetary transmission stage, which drives at least one tool spindle.

BRIEF SUMMARY OF THE INVENTION

The present invention provides a hand-held tool device, having a tool spindle, a striking mechanism and a planetary transmission, that has at least one first planetary transmission stage, which drives the striking mechanism, and a second planetary transmission stage, which drives at least one tool spindle.

It is provided that the planetary transmission has a striking mechanism shut-off clutch. By "tool spindle" one should particularly understand a shaft which transfers a rotational motion from the planetary transmission to a tool chuck of the hand-held tool device. The tool spindle is preferably developed as a solid shaft. Alternatively, the tool spindle could be developed as a hollow shaft. By "striking mechanism" one should particularly understand a device which is provided to generate impact loading and particularly to output it in the direction of an insertable tool. The striking mechanism preferably conducts the impact loading, at least in a percussion drilling operation, advantageously via the tool spindle and/or particularly via the tool chuck on to the insertable tool. The striking mechanism is preferably provided to transfer a rotational motion into a particularly translatory striking motion. "Provided" is to be understood in particular as specially designed and/or equipped. A "planetary transmission" is particularly a transmission having at least one planetary transmission stage. The planetary transmission preferably has only planetary transmission stages. By "planetary transmission stage" one should understand particularly a transmission stage which has at least one planet pinion, that is connected to a planet carrier, the former being coupled to an internal geared wheel in the outward radial direction and to a sun wheel in the inward radial direction. By "drive" one should particularly understand in this connection that the planetary transmission transfers mechanical energy to the striking mechanism for generating striking and to form a rotational motion of the tool chuck to the tool spindle. By "striking mechanism shut-off clutch" one should particularly understand a clutch particularly of a striking mechanism shut-off device which, in at least one operating state, at least prevents and/or advantageously interrupts a drive of the striking mechanism The striking mechanism shut-off clutch preferably interrupts the drive of the striking mechanism when an operator ends a percussion drilling procedure, that is, in particular, that he removes the rotating insertable tool from a workpiece. By the expression that "the planetary transmission has a striking mechanism shut-off clutch" it should particularly be understood, in this connection that the striking mechanism shut-off clutch includes a clutch element which is connected at least torsionally fixed, preferably directly to a component of a planetary transmission stage of the planetary transmission, namely in particular to an internal geared wheel, to a sun wheel and/or to a planet carrier. By "clutch element" one should particularly understand a first element provided to produce a detachable, torsionally fixed connection with a second element, in a state ready for operation. By the design, according to the present invention, of the hand-held tool device, a particularly small, light and efficient striking mechanism is able to be provided, in which the insertable tool is actuated in a striking manner only during a percussion drilling operation.

In a further design, it is provided that the striking mechanism shut-off clutch is situated between the first planetary transmission stage and the second planetary transmission stage, whereby an especially short insertion length may be reached in a constructively simple manner. By the term "situated between two planetary transmission stages" one should understand that a first clutch element of the striking mechanism shut-off clutch is connected torsionally fixed to a component of the first planetary transmission stage of the planetary transmission and a second clutch element of the striking mechanism shut-off clutch is connected torsionally fixed to a component of the second planetary transmission stage of the planetary transmission.

Furthermore, it is provided that the second planetary transmission stage drives the first planetary transmission stage in at least one operating state, whereby an especially effective drilling operation is made possible in response to a compact design.

It is further provided that the striking mechanism shut-off clutch has a clutch element that is supported to be axially displaceable, whereby a constructively simple design is made possible. By "supported to be axially displaceable", one should particularly understand that the clutch element is movably fastened relative to a second clutch element, particularly along a rotational axis of the clutch element.

In addition, it is provided that the tool spindle transfers an axial clutching force to the striking mechanism shut-off clutch, in at least one operating state, whereby a constructively simple design is able to be achieved. By the term "transmit an axial clutching force" should particularly be understood to mean that the tool spindle transfers a force, in at least one operating state which opens the striking mechanism shut-off clutch and/or advantageously closes it. The tool spindle is preferably supported axially movable for the transfer of the clutching motion.

Furthermore, it is provided that the striking mechanism shut-off clutch has a clutch element that is connected torsionally fixed to a planet carrier of the first planetary transmission stage, whereby an advantageous transmission ratio is able to be achieved. This clutch element is preferably the axially displaceably supported clutch element already described. By "connected torsionally fixed" one should understand particularly that the clutch element and the planet carrier are coupled relative to each other immovably about a rotational axis. The clutch element and the planet carrier are advantageously connected with form-locking. The clutch element and the planet carrier are particularly advantageously developed at least partially as one piece. By "at least partially as one piece" one should particularly understand in one continuous material, such as by a welding process and/or an adhesion process, etc., and particularly advantageously connected in an attached form, such as by production by casting and/or production in a monocomponent or multicomponent injection molding method. By "planet carrier" one should particularly understand a component of a planetary transmission stage, that guides a planet pinion rotatably on a circular path.

In one advantageous development of the present invention, it is provided that the striking mechanism shut-off clutch has a clutch element which is connected torsionally fixed to a planet carrier of the second planetary transmission stage,

whereby an advantageous transmission ratio is made possible in a constructively simple manner.

Moreover, it is provided that the planet carrier of the second planetary transmission stage is developed in at least two parts, whereby low wear and high efficiency are able to be achieved. By the term "developed in two parts" one should particularly understand that the planet carrier has a first part and a second part, which are separated from each other at least by one possibly very narrow gap. In particular, the two parts of the planet carrier are not connected in a manner having continuous material. Advantageously, the two parts of the planet carrier are movable with respect to each other, especially in the axial direction.

It is further provided that the planet carrier of the second planetary transmission stage is connected torsionally fixed to the tool spindle, whereby an advantageous transmission ratio is able to be attained.

In addition, it is provided that the first planetary transmission stage is provided to increase the rotational speed of the second planetary transmission stage for driving the striking mechanism, whereby a particularly effective percussion drilling operation is made possible in a small design. By the term "increase a rotational speed" one should particularly understand that the first planetary transmission stage translates a first rotational speed into a higher second rotational speed in an effective direction in which it transfers mechanical energy. The first planetary transmission stage translates a rotational speed, at which the tool chuck is being driven, into a higher rotational speed, at which a striking mechanism spindle is being driven.

It is furthermore provided that the planetary transmission rotatably supports the tool spindle particularly on the side facing away from the tool chuck, whereby a particularly stable support of the tool spindle may be attained, especially by two support points that are at a far distance from each other. By "support rotatably" one should particularly understand that the planetary transmission, in at least one operating state, effects a supporting force on the tool spindle that is perpendicular to a rotational axis of the tool spindle. Furthermore, the striking mechanism spindle advantageously supports the tool spindle rotatably.

In addition, the present invention is based on a hand-held tool having a hand-held tool device according to the present invention. The hand-held tool is preferably provided to actuate the insertable tool in a screw mode, in a drilling mode, in a screw drilling mode and particularly in a chisel mode.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a section of a hand-held tool having a hand-held tool device according to the present invention.

FIG. **2** shows a partially left open section through a striking mechanism and a planetary transmission of the hand-held tool device of FIG. **1**.

FIG. **3** shows a first sectional area A of the striking mechanism of the hand-held tool device of FIG. **1**.

FIG. **4** shows a second sectional area B of the striking mechanism of the hand-held tool device of FIG. **1**.

FIG. **5** shows a perspective representation of a striking mechanism spindle of the striking mechanism of the hand-held tool device of FIG. **1**.

FIG. **6** shows a perspective representation of a beater of the striking mechanism of the hand-held tool device of FIG. **1**.

FIG. **7** shows a sectional area C of a first planetary transmission stage and of a first striking mechanism shut-off device of the hand-held tool device of FIG. **1**.

FIG. **8** shows a sectional area D of a control element and a second striking mechanism shut-off device of the hand-held tool device of FIG. **1**.

FIG. **9** shows a perspective sectional representation of a part of the hand-held tool device of FIG. **1**.

FIG. **10** shows a sectional area E of a spindle blocking device of the hand-held tool device of FIG. **1**.

FIG. **11** shows a sectional area F through blocking means of a spindle blocking device of the hand-held tool device of FIG. **1**.

FIG. **12** shows a sectional area G of a second planetary transmission stage of the hand-held tool device of FIG. **1**.

FIG. **13** shows a sectional area H of a third planetary transmission stage of the hand-held tool device of FIG. **1**.

FIG. **14** shows a sectional area I of a fourth planetary transmission stage of the hand-held tool device of FIG. **1**.

FIG. **15** shows a schematic representation of an operating device and a protective device of the hand-held tool device of FIG. **1**.

FIG. **16** shows an alternative exemplary embodiment of a first striking mechanism shut-off device of a hand-held tool device according to the present invention.

FIG. **17** shows an additional exemplary embodiment of a first striking mechanism shut-off device of a hand-held tool device according to the present invention.

FIG. **18** shows an alternative exemplary embodiment of a striking mechanism switch spring of a hand-held tool device according to the present invention.

FIG. **19** shows an alternative exemplary embodiment of an operating device and a protective device of a hand-held tool device according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** shows a hand-held tool **10***a*. Hand-held tool **10***a* is developed as a percussion drilling screw machine. Hand-held tool **10***a* has a hand-held tool device **12***a* according to the present invention, and hand-held tool housing **14***a* and a battery interface **16***a*. Battery interface **16***a* is provided to supply hand-held tool device **12***a* with electric power from a hand-held tool battery not shown here in greater detail. Hand-held tool housing **14***a* is developed in the shape of a pistol. Hand-held tool housing **14***a* is developed to have many parts. It includes a hand grip **18***a*, by which an operator holds hand-held tool **10***a* during a working process. Hand-held tool device **12***a* includes a tool guide unit **20***a*, a striking mechanism **22***a*, a first striking mechanism shut-off device **24***a*, a second striking mechanism shut-off device **26***a*, a planetary transmission **28***a*, a drive unit **30***a*, an operating device **32***a* and a torque limitation unit **34***a*.

Tool guide unit **20***a* includes a tool chuck **36***a* and a tool spindle **38***a*. During a working process, tool chuck **36***a* fastens an insertable tool not shown here, such as a drill or a screw bit. Tool chuck **36***a* fastens the insertable tool in a force-locking manner. Tool chuck **36***a* has three clamping jaws that an operator is able to fasten movably, which fasten the insertable tool during a working process. In addition, tool chuck **36***a* fastens the insertable tool during a working process in a manner that is axially immovable with respect to tool chuck **36***a* and particularly with respect to tool spindle **38***a*. One part of tool chuck **36***a* and tool spindle **38***a* are connected to each other relatively immovably. In this case, tool chuck **36***a* and tool spindle **38***a* are screwed together. Hand-held tool device **12***a* has a bearing means **40***a*, which supports tool spindle **38***a* on a side facing tool chuck **36***a*. Bearing means **40***a* supports tool spindle **38***a* in an axially displaceable manner. Bearing means **40***a* is connected axially fixed to tool

spindle **38***a*. Bearing means **40***a* is supported axially movable to hand-held tool housing **14***a*. Hand-held tool device **12***a* has an additional bearing means **41***a*, which supports tool spindle **38***a* on a side facing planetary transmission **28***a*. Bearing means **41***a* is developed as a roller bearing, in this case as a needle bearing, whereby a support having little play is made possible. Bearing means **41***a* supports tool spindle **38***a* in an axially displaceable manner. A striking mechanism spindle **46***a* encloses bearing means **41***a*. Bearing means **41***a* is functionally situated between tool spindle **38***a* and striking mechanism spindle **46***a*.

Tool spindle **38***a* includes a striking surface **42***a*, which a beater **44***a* of the striking mechanism **22***a* beats during a percussion drilling operation. Beater **44***a* has a mass that is maximally two-thirds the size of the mass of tool guide unit **20***a*. In this case, the mass of beater **44***a* is less than one-half as great as the mass of tool guide unit **20***a*. The mass of beater **44***a* amounts to about 45% of the mass of tool guide unit **20***a*.

In FIG. **2**, striking mechanism **22***a* and planetary transmission **28***a* are shown in greater detail. Striking mechanism **22***a* has beater **44***a*, striking mechanism spindle **46***a*, a striking mechanism spring **48***a*, a striking mechanism driving device **50***a* and a beater guide **52***a*. Beater **44***a* is supported translatorially movable in striking direction **54***a*. Striking direction **54***a* is aligned parallel to an axial direction of striking mechanism spindle **46***a*.

FIGS. **3** and **4** show a sectional area A and a sectional area B of striking mechanism **22***a*. Beater guide **52***a* supports beater **44***a* torsionally fixed with respect to hand-held tool housing **14***a*. Beater guide **52***a* has three guide rods **56***a* on which beater **44***a* slides. Guide rods **56***a* are situated regularly around beater **44***a*. Beater **44***a* has sliding surfaces **58***a*, which enclose guide rods **56***a* in a plane perpendicular to striking direction **54***a* over 180 degrees. Beater **44***a* encloses striking mechanism spindle **46***a* in a plane aligned perpendicular to striking direction **54***a*, over 360 degrees. In addition, beater **44***a* encloses tool spindle **38***a* on the plane over 360 degrees. Moreover, striking mechanism spindle **46***a* encloses on the plane tool spindle **38***a* over 360 degrees. Striking mechanism spindle **46***a* is situated coaxially with tool spindle **38***a*.

Striking mechanism spring **48***a* accelerates beater **44***a* before a strike in striking direction **54***a*. For this purpose, hand-held tool housing **14***a* supports striking mechanism spring **48***a* on a side facing away from beater **44***a*. Striking mechanism spring **48***a* presses directly against beater **44***a*. Beater **44***a* has a spring fastening **60***a*. Spring fastening **60***a* is developed as an annular depression. FIG. **5** shows striking mechanism spindle **46***a* in a perspective view. FIG. **6** shows beater **44***a* in a perspective view. Beater driving device **50***a* has a first curve guide **62***a* and a second first curve guide **64***a*. Curve guides **62***a*, **64***a* each include a guiding curve **66***a*, **68***a* and connecting means **70***a*, **72***a*. Connecting means **70***a*, **72***a* are developed to be ball-shaped. Beater **44***a* supports connecting means **70***a*, **72***a* in place with respect to beater **44***a*. Beater **44***a* has hemisphere-shaped fastening recesses **74***a*. Connecting means **70***a*, **72***a* slide in guiding curves **66***a*, **68***a* during a percussion drilling operation. Striking mechanism spindle **46***a* has a part of curve guides **62***a*, **64***a*, namely, guiding curve **66***a*, **68***a*. Striking mechanism spindle **46***a* borders a space in which connecting means **70***a*, **72***a* move during a percussion drilling operation. Striking mechanism spindle **46***a* is developed as a hollow shaft. Planetary transmission **28***a* drives striking mechanism spindle **46***a*. For this purpose, striking mechanism spindle **46***a* has a toothing **76***a* on the side facing away from tool chuck **36***a*. Guiding curves **66***a*, **68***a* each have an impact-free running region **78***a*, **80***a*, an impact wind-up region **82***a*, **84***a* and an assembly recess **86***a*, **88***a*. During assembly, connecting means **70***a*, **72***a* are inserted through assembly recesses **86***a*, **88***a* into fastening recesses **74***a* of beater **44***a*. In a percussion drilling operation, striking mechanism spindle **46***a* rotates clockwise as seen in striking direction **54***a*. Impact wind-up regions **82***a*, **84***a* are developed to be spiral-shaped. They extend over 180 degrees about a rotational axis **90***a* of striking mechanism spindle **46***a*. Impact wind-up regions **82***a*, **84***a* move connecting means **70***a*, **72***a*, and with that, beater **44***a* counter to striking direction **54***a* in the percussion drilling operation. Consequently, striking mechanism **22***a* has connecting means **70***a*, **72***a* which, in at least one operating state, transfer a motion from striking mechanism spindle **46***a* to beater **44***a*.

Impact-free running regions **78***a*, **80***a* each connect two ends **92***a*, **94***a*, **96***a*, **98***a* of impact wind-up regions **82***a*, **84***a*. Impact-free running regions **78***a*, **80***a* extend over 180 degrees about a rotational axis **90***a* of striking mechanism spindle **46***a*. Impact-free running regions **78***a*, **80***a* each have an impact side **100***a*, **102***a* which, starting from an end **94***a*, **96***a* of impact wind-up region **82***a*, facing planetary transmission **28***a*, runs approximately parallel to striking direction **54***a*. After the connecting means **70***a*, **72***a* penetrate impact-free running regions **78***a*, **80***a*, striking mechanism spring **48***a* accelerates beater **44***a* and connecting means **70***a*, **72***a* in striking direction **54***a*. In this context, connecting means **70***a*, **72***a* move through impact-free running regions **78***a*, **80***a*, without experiencing an axial force, until beater **44***a* hits striking surface **42***a*. Curve guides **62***a*, **64***a* are situated about rotational axis **90***a*, offset by 180 degrees. Curve guides **62***a*, **64***a* are situated one behind the other in the axial direction.

Planetary transmission **28***a* has first planetary transmission stage **104***a*, a second planetary transmission stage **106***a*, a third planetary transmission stage **108***a* and a fourth planetary transmission stage **110***a* FIG. **7** shows a sectional area C of first planetary transmission stage **104***a*. Planetary transmission stages **104***a*, **106***a*, **108***a*, **110***a* shown in FIGS. **7**, **12**, **13** and **15** have toothed wheels having a number of teeth that appears meaningful to one skilled in the art. The toothed wheels of planetary transmission stages **104***a*, **106***a*, **108***a*, **110***a* engage with one another, which, in this case, is partially not shown like that. First planetary transmission stage **104***a* increases a first rotational speed of second planetary transmission stage **106***a* for driving striking mechanism **22***a*. Second planetary transmission stage **106***a* drives tool spindle **38***a* at this first rotational speed. Toothing **76***a* of striking mechanism spindle **46***a* forms a sunwheel of first planetary transmission stage **104***a*. Toothing **76***a* meshes with planet pinions **112***a* of first planetary transmission stage **104***a*, which are guided by a planet carrier **114***a* of first planetary transmission stage **104***a*. An internal geared wheel **116***a* of first planetary transmission stage **104***a* meshes with planet pinions **112***a* of first planetary transmission stage **104***a*.

During a percussion drilling operation, first striking mechanism shut-off device **24***a* fixes internal geared wheel **116***a* of first planetary transmission stage **104***a* immovable with respect to hand-held tool housing **14***a*. First striking mechanism shut-off device **24***a* is provided to switch on beater driving device **50***a* in response to a first right-hand drilling rotation direction, and to switch off automatically beater driving device **50***a* in response to a second, left-hand drilling rotation direction. First striking mechanism shut-off device **24***a* acts on internal geared wheel **116***a* of first planetary transmission stage **104***a*. First striking mechanism shut-off device **24***a* blocks internal geared wheel **116***a* of first planetary transmission stage **104***a* at the first right-hand drilling rotation direction. First striking mechanism shut-off device **24***a* releases internal geared wheel **116***a* of first plan-

etary transmission stage **104***a* in response to second, left-hand drilling rotation direction, so that it is able to rotate. For this purpose, striking mechanism shut-off device **24***a* has three clamping mechanisms **122***a*. Clamping mechanisms **122***a* each include a blocking means **124***a*, a first clamping surface **126***a*, a second clamping surface **128***a* and free-wheeling surfaces **130***a*. Sealing means **124***a* is developed as a roller. First clamping surface **126***a* forms an area, lying outside, of a surface of internal geared wheel **116***a* of first planetary transmission stage **104***a*. Second clamping surface **128***a* is situated immovable with respect to hand-held tool housing **14***a*. During an operation in the first, right-hand drilling rotation direction, blocking means **124***a* clamp between first clamping surfaces **126***a* and second clamping surface **128***a*. During an operation in the second, left-hand drilling rotation direction, free-wheeling areas **130***a* guide blocking means **124***a* and prevent clamping.

Furthermore, FIG. **7** shows connecting means **118***a*, which connects tool spindle **38***a* and a planet carrier **120***a* of the second planetary transmission stage **106***a* in a torsionally fixed manner. Connecting means **118***a* connects tool spindle **38***a* and planet carrier **120***a* of second planetary transmission stage **106***a* in an axially displaceable manner, in this case.

Moreover, FIGS. **3**, **4** and **7** show three first transfer means **132***a* of second striking mechanism shut-off device **26***a*. Transfer means **132***a* are implemented as rods. FIG. **8** shows a sectional area D through a control element **134***a* of hand-held tool device **12***a*. FIG. **9** shows second striking mechanism shut-off device **26***a* in a perspective sectional representation. Control element **134***a* supports tool guide unit **20***a* in a screw mode shown in FIGS. **1**, **8** and **9** and in a drilling mode in a direction counter to striking direction **54***a*. A force applied to tool guide unit **20***a* acts via bearing means **40***a*, a second transfer means **136***a* of second striking mechanism shut-off device **26***a* and first transfer means **132***a* on support areas **138***a* of control element **134***a*. Control element **134***a* has three recesses **140***a*. In a percussion drilling operation shown in FIG. **2**, first transfer means **132***a* are able to be inserted into recesses **140***a*, whereby tool guide unit **20***a* is axially movable.

Second striking mechanism shut-off device **26***a* has a striking mechanism shut-off clutch **142***a*. Striking mechanism shut-off clutch **142***a* is partially developed as one piece with planetary transmission **28***a*. Striking mechanism shut-off clutch **142***a* is situated between first planetary transmission stage **104***a* and second planetary transmission stage **106***a*. Striking mechanism shut-off clutch **142***a* has a first clutch **144***a* which is connected torsionally fixed to a planet carrier **114***a* of first planetary transmission stage **104***a*. Striking mechanism shut-off clutch **142***a* has a second clutch element **146***a* which is connected torsionally fixed to a planet carrier **120***a* of first planetary transmission stage **106***a*. In the screw mode and the drilling mode shown, striking mechanism shut-off clutch **142***a* is opened. In a percussion drilling operation, tool spindle **38***a* transfers an axial clutching force to striking mechanism shut-off clutch **142***a* when the operator presses an insertable tool against a workpiece. The clutching force closes striking mechanism shut-off clutch **142***a*. In FIG. **2**, striking mechanism shut-off clutch **142***a* is shown closed. When the operator of the insertable tool removes it from the workpiece, a striking mechanism switching spring **148***a* of hand-held tool device **12***a* opens striking mechanism shut-off clutch **142***a*.

Planet carrier **120***a* of second planetary transmission stage **106***a* is developed as two parts. A first part **150***a* of planet carrier **120***a* of second planetary transmission stage **106***a* is connected torsionally fixed to tool spindle **38***a*. First part **150***a* of planet carrier **120***a* is connected to tool spindle **38***a* in an axially displaceable manner, whereby planet carrier **120***a* remains torsionally coupled to tool spindle **38***a* even during a striking maneuver. Thus, first part **150***a* is permanently connected to tool spindle **38***a*. First part **150***a* of planet carrier **120***a* is supported dispaceably against striking mechanism switching spring **148***a*. A second part **152***a* of planet carrier **120***a* of second planetary transmission stage **106***a* is connected torsionally fixed to first part **150***a* of planet carrier **120***a*. First part **150***a* and second part **152***a* of planet carrier **120***a* are connected to each other in an axially displaceable manner. First part **150***a* and second part **152***a* of planet carrier **120***a* are connected permanently in a torsionally fixed manner.

FIG. **10** shows a sectional area of a spindle blocking device **154***a* of hand-held tool device **12***a*. Spindle blocking device **154***a* is provided to connect tool spindle **38***a* to hand-held tool housing **14***a* in a torsionally fixed manner, when a tool torque is applied to tool chuck **36***a*, for instance, during the clamping of an insertable tool into tool chuck **36***a*. Spindle blocking device **154***a* is partially developed as one piece with planet carrier **120***a* of second planetary transmission stage **106***a*. Spindle blocking device **154***a* has blocking means **156***a*, first clamping surfaces **158***a*, a second clamping surface **160***a* and free-wheeling surfaces **162***a*. Blocking means **156***a* are developed in a roller-shaped manner. First clamping surfaces **158***a* are developed as areas of a surface of first part **150***a* of planet carrier **120***a* of second planetary transmission stage **106***a*. First clamping surfaces **158***a* are developed to be flat. Second clamping surface **164***a* is developed as the inner side of a clamping ring **164***a* of spindle blocking device **154***a*. Clamping ring **164***a* is connected torsionally fixed to hand-held tool housing **14***a*. Free-wheeling surfaces **162***a* are developed as areas of a surface of first part **152***a* of planet carrier **120***a* of second planetary transmission stage **106***a*. When a tool torque is applied to tool chuck **36***a*, blocking means **156***a* clamp between first clamping surfaces **158***a* and second clamping surface **160***a*. When drive unit **30***a* is driving, free-wheeling surfaces **162***a* guide blocking means **156***a* on a circular path and prevent clamping. First part **150***a* and second part **152***a* of planet carrier **120***a* are geared to each other, having play. FIGS. **1**, **2**, **9** and **10** shows torque limitation unit **34***a*. Torque limitation unit **34***a* is provided to limit the tool torque that is maximally output by tool chuck **36***a* in a screw mode. Torque limitation unit **34***a* includes an operating unit **166***a*, an adjusting element **168***a*, limitation strings **170***a*, transfer means not shown in greater detail, first impact surfaces **172***a*, a second impact surface **174***a* and limitation means **176***a*. Operating element **166***a* is developed to be ring-shaped. It follows tool chuck **36***a*, in the direction of planetary transmission **28***a*. Operating element **166***a* has a setting screw thread **178***a*, which is matched to a setting screw thread **180***a* of adjusting element **168***a*. Adjusting element **168***a* is supported torsionally fixed and axially displaceable. A rotation of operating element **166***a* displaces adjusting element **168***a* in the axial direction. Limiting springs **170***a* are supported on one side on adjusting element **168***a*. Limiting springs **170***a* are supported on another side via the transfer means to impact means **182***a* of torque limitation unit **34***a*. A surface of impact means **182***a* has first impact surface **172***a*. In screw mode, impact means **182***a* is displaceably supported in the axial direction by limiting springs **170***a*. Second impact surface **174***a* is developed as an area of the surface of an internal geared wheel **184***a* of second planetary transmission stage **106***a*. Second striking surface **174***a* has trough-shaped depressions **186***a*. Limiting means **176***a* are developed in a ball-shaped manner. Limiting means **176***a* are supported dis-

placeably in tube-shaped recesses **188***a* in impact direction **54***a*. FIG. **11** shows a sectional area F of torque limitation unit **34***a*. During a screw process, limitation means **176***a* are situated in the trough-shaped recessions **186***a*. Limitation means **176***a* fasten internal geared wheel **184***a* of second planetary transmission stage **106***a*. When the maximum tool torque, that is set, has been reached, limitation means **176***a* press away impact means **182***a* against limiting springs **170***a*. Then, limitation means **176***a* each jump in the next one of the trough-shaped depressions **186***a*. In the process, internal geared wheel **194***a* of second planetary transmission stage **106***a* is turning, whereby the screw process is interrupted.

Control element **134***a* of hand-held tool device **12***a* has supporting means **190***a*, which, at least during a drilling operation, prevent an axial motion of impact means **182***a*. For this purpose, supporting means **190***a* support impact means **182***a* in the axial direction. Impact means **182***a* has screw recesses **192***a*, into which impact means **182***a* dip in response to reaching the maximum tool torque, particularly in a screw operation as shown in FIG. **9**. Supporting means **190***a* are situated accordingly during a screw setting of control element **134***a*. In the case of a percussion drilling operation, support means **190***a* each also prevent an axial motion of impact means **182***a* and, with that, a response of torque limitation unit **34***a*. As an alternative, impact means could also be situated, during a percussion drilling operation, so that they are able to dip into screw recesses. Thus, a torque limitation unit would be active in the percussion drilling operation.

FIG. **12** shows a sectional area G of second planetary transmission stage **106***a*. At least during a drilling operation, internal geared wheel **184***a* of second planetary transmission stage **106***a* is supported, protected from a complete revolution, in hand-held tool housing **14***a*. Planet pinions **194***a* of second planetary transmission stage **106***a* mesh with internal geared wheel **184***a* and a sun wheel **196***a* of second planetary transmission stage **106***a*.

FIG. **13** shows a sectional area H of third planetary transmission stage **108***a*. Sun wheel **196***a* of second planetary transmission stage **106***a* is connected torsionally fixed to a planet carrier **198***a* of third planetary transmission stage **108***a*. Planet pinions **200***a* of third planetary transmission stage **108***a* mesh with a sun wheel **202***a* and an internal geared wheel **204***a* of third planetary transmission stage **108***a*. Internal geared wheel **204***a* of third planetary transmission stage **108***a* has a gearing **206***a* which connects internal geared wheel **204***a* of third planetary transmission stage **108***a* torsionally fixed to hand-held tool housing **14***a*, in a first transmission ratio.

FIG. **14** shows a sectional area I of third planetary transmission stage **108***a*. Sun wheel **202***a* of third planetary transmission stage **108***a* is connected torsionally fixed to a planet carrier **208***a* of fourth planetary transmission stage **110***a*. Planet pinions **210***a* of fourth planetary transmission stage **110***a* mesh with a sun wheel **212***a* and an internal geared wheel **214***a* of fourth planetary transmission stage **110***a*. Internal geared wheel **214***a* is connected torsionally fixed to hand-held tool housing **14***a*. Sun wheel **212***a* of fourth planetary transmission stage **110***a* is connected torsionally fixed to a rotor **216***a* of drive unit **30***a*.

Internal geared wheel **204***a* of third planetary transmission stage **108***a* is supported displaceably in the axial direction, as shown in FIG. **2**. In the first transmission ratio, internal geared wheel **204***a* of third planetary transmission stage **108** is connected torsionally fixed to hand-held tool housing **14***a*. In the second transmission, internal geared wheel **204***a* of third planetary transmission stage **108***a* is connected displaceably to planet carrier **208***a* of fourth planetary transmission stage **110***a*, and supported rotatably with respect to hand-held tool housing **14***a*. Consequently, there comes about a step-down ratio of the first transmission between rotor **216***a* of drive unit **30***a* and planet carrier **198***a* of third planetary transmission stage **108***a* which is greater than a step-down ratio of the second transmission.

Operating device **32***a* has a first operating element **218***a* and a second operating element **220***a*. First operating element **218***a* is situated on the side of hand-held tool housing **14***a* that faces away from handle **18***a*. It is supported movably parallel to the axial direction of planetary transmission **28***a*. First operating element **218***a* is connected via adjusting means **222***a* of operating device **32***a* to internal geared wheel **204***a* of third planetary transmission stage **108***a* in the axial direction. Internal geared wheel **204***a* of third planetary transmission stage **108***a* has a groove **224***a* in which adjusting means **222***a* engages. Thus, internal geared wheel **204***a* of third planetary transmission stage **108***a* is connected to adjusting means **222***a* in the axial direction, axially rotatable with respect to adjusting means **222***a*. Adjusting means **222***a* is developed to be springy, whereby the transmission from a rotary position of internal geared wheel **204***a* of third planetary transmission stage **108***a* is able to be adjusted independently. When first operating element **218***a* is pushed in the direction of tool chuck **36***a*, this sets the first transmission. When second operating element **220***a* is pushed away from tool chuck **36***a*, this sets the second transmission.

Second operating element **220***a* is situated on the side of hand-held tool housing **14***a* that faces away from handle **18***a*. Second operating element **220***a* is situated displaceable about an axis which is aligned parallel to the axial direction of planetary transmission **28***a*. Second operating element **220***a* is connected torsionally fixed to control element **134***a* of hand-held tool device **12***a*. Using second operating element **220***a*, one is able to set the screw mode, the drilling mode and the percussion drilling mode. When second operating element **220***a* is pushed to the left, as seen in striking direction **54***a*, this sets the percussion drilling mode. When second operating element **220***a* is pushed to the right, as seen in striking direction **54***a*, this sets the screw mode. When second operating element **220***a* is pushed to the middle, as seen in striking direction **54***a*, this sets the drilling mode.

FIG. **15** schematically shows a protective device **226***a* of hand-held tool device **12***a*, which prevents an operation in the first transmission in the percussion drilling operation. In FIG. **15**, the first transmission and the drilling mode are set. Protective device **226***a* is partially developed as one piece with operating device **32***a*. First operating element **218***a* has first blocking means **228***a* of protective device **226***a* connected to it in an attached form. Second operating element **220***a* has second blocking means **230***a* of protective device **226***a* connected to it in an attached form. Blocking means **228***a* are each developed tongue-shaped. First blocking means **228***a* extends in the direction of second operating element **220***a*. Second blocking means **230***a* extends in the direction of first operating element **218***a*. Protective device **226***a* prevents switching over into the percussion drilling operation when the first transmission is set. Protective device **226***a* prevents switching over into the first transmission when the percussion drilling operation is set.

Drive unit **30***a* is developed as an electric motor. Drive unit **30***a* has a maximum torque which causes a maximum tool torque in the first transmission of more than 15 Nm, and in the second transmission of less than 15 Nm. The maximum tool torque in the first transmission amounts to 30 Nm. The maximum tool torque in the second transmission amounts to 10

Nm. In this context, the tool torque should be determined according to Standard DIN EN 60745.

Striking mechanism switching spring **148***a* of hand-held tool device **12***a*, in the case of a percussion drilling operation, opens striking mechanism shut-off clutch **142***a* when the operator removes the insertable tool from the workpiece. Striking mechanism switching spring **148***a* is situated coaxially to planetary transmission stages **104***a*, **106***a*, **108***a*, **110***a* of planetary transmission **28***a*. Second planetary transmission stage **106***a* and third planetary transmission stage **108***a* enclose striking mechanism switching spring **148***a* in each case in at least one plane, which is aligned perpendicular to the axial direction of planetary transmission **28***a*. Second planetary transmission stage **106***a* and third planetary transmission stage **108***a* are each situated effectively between at least two additional planetary transmission stages **104***a*, **106***a*, **108***a*, **110***a* of planetary transmission **28***a*. Planet carrier **120***a* of second planetary transmission stage **106***a* supports striking mechanism switching spring **148***a* on the side facing away from tool chuck **36***a*.

FIGS. **16** through **19** show additional exemplary embodiments of the present invention. The following descriptions and the drawings are limited essentially to the differences between the exemplary embodiments. Regarding components that are designated in the same way, particularly regarding components having identical reference numerals, it is fundamentally possible to refer also to the drawings and/or the description of the other exemplary embodiments, especially of FIGS. **1** through **15**. In order to distinguish the exemplary embodiments, the letter a is added after the reference numerals of the exemplary embodiment in FIGS. **1** through **15**. In the exemplary embodiments of FIGS. **16** through **19**, the letter a is replaced by the letter b or by the letters b through e.

FIG. **16** shows schematically an additional, alternative exemplary embodiment of a first striking mechanism shut-off device **24***b*. A planet carrier **114***b* of a first planetary transmission stage **104***b* is developed in two parts. A first part **232***b* of the planet carrier **114***b* guides planet pinions **112***b* of first planetary transmission stage stage **104***b*. A second part **234***b* of planet carrier **114***b* is torsionally coupled to a second planetary transmission stage **106***b*. A first striking mechanism shut-off device **24***b* of a striking mechanism **22***b* has a freewheel **236***b* that appears meaningful to one skilled in the art, which connects first part **232***b* and second part **234***b* of planet carrier **114***b* in response to a right hand drilling rotation direction and separates them in response to a left handed drilling rotation direction. An internal geared wheel **116***b* of first planetary transmission stage **104***b* is permanently connected to a hand-held tool housing, torsionally fixed.

FIG. **17** shows schematically a next exemplary embodiment of a first striking mechanism shut-off device **24***c*. A striking mechanism spindle **46***c* of a striking mechanism **22***c* is developed in two parts. A first part **238***c* of striking mechanism spindle **46***c* is connected to a striking mechanism drive device. A second part **240***c* of striking mechanism spindle **46***c* is connected to a second planetary transmission stage **106***c*. First striking mechanism shut-off device **24***c* has a freewheel **242***c* that appears meaningful to one skilled in the art, which connects first part **238***c* and second part **240***c* of striking mechanism spindle **46***c* torsionally fixed, in response to a right hand drilling rotation direction and separates them in response to a left handed drilling rotation direction. An internal geared wheel **116***c* of first planetary transmission stage **104***c* is permanently connected, torsionally fixed, to a hand-held tool housing.

FIG. **18** shows a further exemplary embodiment of a striking mechanism switching spring **148***d*. A second planetary transmission stage **106***d* supports striking mechanism switching spring **148***d* on the side facing the tool chuck. A drive unit **30***d* supports striking mechanism switching spring **148***d* on the side facing away from the tool chuck. Second planetary transmission stage **106***d*, a third planetary transmission stage **108***d* and a fourth planetary transmission stage **110***d* enclose the striking mechanism switching spring **148***d* in each case in at least one plane, which is aligned perpendicular to an axial direction of planetary transmission stages **106***d*, **108***d*, **110***d*. Drive unit **30***d* is connected torsionally fixed to a part of planetary transmission stage **110***d*.

FIG. **19** shows an alternative exemplary embodiment of operating device **32***e* and a protective device **226***e*. Operating device **32***e* has a first operating element **218***e* and a second operating element **220***e*. Operating elements **218***e*, **220***e* are supported in a pivotable manner about rotational axes **244***e*, **246***e*. Operating elements **218***e*, **220***e* have a disk-shaped basic form. First operating element **218***e*, which is not shown in greater detail, is connected to a planetary transmission via a mechanism that appears meaningful to one skilled in the art. A first transmission and a second transmission are able to be set using first operating element **218***e*. Second operating element **220***e*, which is not shown in greater detail, is connected to a control element via a mechanism that appears meaningful to one skilled in the art. Using second operating element **220***e*, one is able to set the screw mode, the drilling mode and the percussion drilling mode. Moreover, one might be able to set a chisel mode.

Protective device **226***e* has a freewheeling region **248***e* bordered by first operating element **218***e*. Protective device **226***e* has a freewheeling region **250***e* bordered by second operating element **250***e*. Freewheeling region **248***e* of first operating element **218***e* enables the setting of the screw mode, the drilling mode and the percussion drilling operation when a second transmission has been set. Freewheeling region **250***e* of second operating element **220***e* enables the setting of the screw mode and the drilling mode when a second transmission has been set. In the percussion drilling operation, protective device **226***e* prevents setting the first transmission. When the first transmission has been set, protective device **226***e* prevents setting the percussion drilling operation.

What is claimed is:

1. A hand-held tool device, comprising:

a tool spindle including a striking surface which is oriented substantially perpendicularly relative to an axial direction of the tool spindle;

a striking mechanism configured to transfer rotational motion into a translatory striking motion, the striking mechanism including a striker which is configured to transfer the translatory striking motion to the striking surface of the tool spindle; and

a planetary transmission having (i) at least one first planetary transmission stage which drives the striking mechanism, (ii) a second planetary transmission stage which drives at least the tool spindle, and (iii) a striking mechanism shut-off clutch,

wherein the striking mechanism shut-off clutch is situated between the first planetary transmission stage and the second planetary transmission stage,

wherein the tool spindle is configured to transfer an axial clutching force in at least one operating state to the striking mechanism shut-off clutch which at least one of opens the striking mechanism shut-off clutch or closes the striking mechanism shut-off clutch.

2. The hand-held tool device as recited in claim 1, wherein the second planetary transmission stage drives the first planetary transmission stage in at least one operating state.

3. The hand-held tool device as recited in claim 1, wherein the striking mechanism shut-off clutch has a clutch element which is supported in an axially displaceable manner.

4. The hand-held tool device as recited in claim 1 wherein the striking mechanism shut-off clutch has a clutch element which is connected torsionally fixed to a planet carrier of the first planetary transmission stage.

5. The hand-held tool device as recited in claim 1, wherein the striking mechanism shut-off clutch has a clutch element which is connected torsionally fixed to a planet carrier of the second planetary transmission stage.

6. The hand-held tool device as recited in claim 5, wherein the planet carrier of the second planetary transmission stage is configured in at least two parts.

7. The hand-held tool device as recited in claim 5, wherein the planet carrier of the second planetary transmission stage is connected torsionally fixed to the tool spindle.

8. The hand-held tool device as recited in claim 1, wherein the first planetary transmission stage is provided to increase a rotational speed of the second planetary transmission stage so as to drive the striking mechanism.

9. The hand-held tool device as recited in claim 8, wherein the planetary transmission supports the tool spindle in a rotatable manner.

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